Empirica
https://doi.org/10.1007/s10663-018-9421-y

ORIGINAL PAPER

Urban sprawl and local fiscal burden: analysing the Spanish case

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Abstract

Urban sprawl is rapidly occurring in many Spanish urban areas. The objective of this paper is to evaluate how the trend of building dispersion of new residential areas may be affecting the fiscal stability of local governments in Spain. The wide diversity of the characteristics of Spanish urban areas as well as the existence of very similar local fiscal structures make this case particularly interesting. After delimiting the urban areas and the spatial unit of analysis, a precise index of urban sprawl, calculated with geo-referenced digital cartography, is used. Using the spatially disaggregated information of taxes from the Spanish National Institute for Fiscal Studies allows for a measure of fiscal burden by local areas and the ability to distinguish among types of taxes. Control variables are also available at the local level from the Spanish Census and other databases. Two methods, quantile regressions and ordinary least squares, are used in order to measure not only the average change but the heterogeneity across the distribution of the local fiscal burden associated with the changes in urban sprawl, whilst controlling for other explanatory variables in the model. The results indicate that higher levels of urban sprawl imply higher local fiscal burden. By tax categories, the phenomenon of urban sprawl particularly affects both local indirect and direct taxation. These results suggest that local decision-makers should consider urban planning as one of the fundamental tools to assure long-term local fiscal sustainability.

Keywords Urban sprawl · Fiscal burden · Local public services · Geo-referenced digital cartography · Quantile regression · Spain

JEL Classification R1 · R5 · H7 · H8

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Published online: 23 October 2018

1 Introduction

This paper aims to measure the impact of the increasing trend of sprawl in Spanish cities on the fiscal burden at the local level. The environmental effects of sprawl as well as its impacts on social interaction in cities or mobility are widely documented in previous papers, but the effect of sprawl on the public accounts and fiscal sustainability is still an open question. From the theoretical perspective, the potential effect of sprawl on fiscal balances of local governments is not clear. On the one hand, municipalities could acquire more resources from construction, local economic activities and property taxes. On the other hand, the cost of providing services and improving infrastructure could be incremental, therefore significantly reducing the efficiency in dispersed areas. The existing empirical literature suggests that low-density areas cause a negative impact on costs of local services and fiscal stability, but, at the same time, the attraction of population and construction activities could increase fiscal revenues.

Since the 2000s the studies of local fiscal sustainability have started taking a greater importance primarily due to the need of understanding the efficiencies of municipal budgets. The diverse approaches to the analysis and management of fiscal conditions are reflected in the *Handbook of Local Government Fiscal Health*, edited by Levine et al. (2013), demonstrating that, while there is some agreement on fiscal health as a theoretical concept, the consensus on how to measure, predict, and manage the decline in fiscal health is still unachieved. In line with this literature we are interested in observations of the impact that physical development of a city into a more sprawled instead of a compacted one could have on the fiscal sustainability of that local area.

In the discussions of urban sprawl Spain becomes an interesting case due to its highly decentralized government with 17 regional governments and 8114 municipalities that manage 35% and 13% of total public expenditures, respectively. Besides, Spain is the sixth country in the degree of authority of regional governments.[1] Different authors have recently addressed municipal budget issues, especially in the wake of the economic crisis, when not all Spanish municipalities suffered equally from the downturn (Caramés Viéitez 2005; Lopez-Laborda et al. 2006; Suárez Pandiello et al. 2008; Benito Pérez et al. 2010; Martinez-Vazquez and Timofeev 2010; Suárez Pandiello and Fernández Llera 2012; Delgado et al. 2015). Prior to the crisis, the local budgetary situation, such as the size of a municipality (as the cost of providing municipal public services is related, among others, to size population) and the obligation (or not) in the provision of services, had a significant impact on the deterioration of municipal public accounts (Portillo Navarro 2016). This deterioration of the local accounts is also closely related to the evolution of urban activities

[1] According to the Regional Authority Index on the basis of data for 2005, Spain is in the sixth position after Germany, Belgium, the United States, Canada, and Italy (Hooghe et al. 2010). This index is measured across eight dimensions: institutional depth, policy scope, fiscal autonomy, representation, law making, executive control, fiscal control, and constitutional reform.

in Spain (Suárez Pandiello and Fernández Llera 2012).[2] Thus, in the years of the housing bubble, the Spanish municipalities obtained a significant increase in their income mainly due to the inflow of resources from urban planning. Later, the crisis ignited by the real estate bubble reduced the local revenues from taxes, fees, licenses, etc.

The evolution and advancement of technologies allowed integration of quantitative information on urban sprawl within different disciplines (geography, town planning, territorial planning, environmental science, economics, sociology and even public health) leading to numerous, and sometimes conflicting, definitions (Galster et al. 2001; Squires 2002; Davoudi 2003; Glaeser and Kahn 2004; Richardson and Chnag-Hee 2004; Sturn and Cohen 2004; Jaeger and Schwick 2014). For this study, while considering all indicators, we find the USI indicator measured by Rubiera et al. (2016) to be the most useful and applicable. The authors use the procedure for measuring sprawl proposed by Burchfield et al. (2005) and apply it to the case of Spain. The sprawl and the fiscal burden in urbanized areas are measured according to the official delimitation of the Spanish government. Section 3 provides a more detailed discussion of the spatial unit of the analysis and the USI indicator as the main explanatory variable for our study of the local fiscal burden in Spain.

This paper examines in depth the effect of urban sprawl as a determinant of local fiscal burden by revealing the impact of the households' housing decisions on the distribution of the local fiscal burden across the Spanish municipalities. The implications of these results are twofold. First, our results add to the existing body of the literature on fiscal decentralization by considering a very important measure that aims to capture geographical differences. It contributes to the limited literature on the explanatory analysis of the local fiscal burden on taxpayers through the specified methodology of defining urban sprawl for the entire national territory of Spain. Thus, this study sheds light on the state rescaling theory and challenges the efficiency claims of fiscal decentralization. Second, more importantly, our findings add to the evidence that geography matters in the development process of municipalities. In particular, the paper uses a very precise method of defining and measuring urban sprawl. A new digital cartography and geographical information system allows us to obtain an international comparable urban sprawl index (USI) that has not been previously used in the literature for evaluation of the fiscal consequences of urban sprawl. The USI is applied to all urban areas of Spain. The urban structure of Spain is particularly interesting, since it contains a complete spectrum of urban areas of different sizes, economic structures, climatic and geographic conditions, which also have very similar local fiscal systems and local public service obligations.

In terms of methodology, ordinary least squares (OLS) estimations are supplemented with quantile regression (QR) techniques to define the effects of sprawl in the mean as well as across the entire distribution of the local fiscal burden. To observe in depth the variation in results for different types of taxation, we also

[2] For example, the Tax on buildings, facilities and works -according to data from the Ministry of Finance and Public Administration—provided 2637.8 million euros to municipalities in 2006 but only 482.2 million euros in 2014.

separately analyse these effects through the perspective of direct and indirect taxation in the Spanish local fiscal system.

The paper is structured as follows. In the next section, a brief review of the literature regarding the urban sprawl phenomenon and its implications from the fiscal perspective is provided. In Sect. 3, a delimitation of the spatial unit of analysis is presented as well as the description of the main variables, paying particular attention to the definition of urban sprawl and calculation of the index using digital geo-referenced cartography. It also includes the definitions of local fiscal burden and different taxes. An empirical model with the econometric strategy is presented in Sect. 4. Section 5 exhibits and discusses the main results. Finally, Sect. 6 concludes and offers policy implications.

2 Literature review

Urban sprawl is one of the most studied and controversial urban phenomena. After the industrial revolution cities grew upward. In the second part of the last century the growth pattern of some North American cities occurred through the intensive use of land pushing the cities further out. The North American model of a sprawled city rapidly extended, first to Latin America (Polèse and Champain 2003) and later to Asia (Bunnel et al. 2002), ultimately becoming a global phenomenon (Brueckner 2000). Traditionally, the old European cities were different from the newer ones of America or Asia. The cities of the old continent were strongly concentrated around a dense historical center and its commercial and business extensions (Couch et al. 2007). However, during the last four decades, new tendencies of urban sprawl have appeared (Arribas-Bel et al. 2011; Christiansen and Loftsgarden 2011). According to the European Commission (2006), the eastern and southern countries of the old continent are at a greater risk of an explosive process of urban expansion.

The case of Spain is one of the most interesting in Europe. Some urban areas of the Iberian Peninsula experience higher pressure for construction developments due to growing tourism and demand for second residences. The Spanish economy has been drastically affected by the construction sector, suffering one of the largest real estate bubbles in Europe (Romero 2012). In Spain the last four decades of the past century are characterized by very rapid economic growth presenting a very strong and concentrated process of urbanization. The cities, such as Madrid and Barcelona, doubled their populations in less than twenty years.[3] Other major metropolitan areas experienced growth characterized by the integration of different cities or towns in one unit.[4] Meanwhile, rural areas lost most of their populations in just two decades (Gutiérrez et al. 2017). Additionally, many Spanish cities were intensely affected by the explosion of the tourism sector during the last decades. According to

[3] Catalan et al. (2008) and Muñoz (2003) develop an urban sprawl analysis for the Mediterranean coast. García-Lopez (2012) analyzes the specific case of Barcelona and, Moliní and Salgado (2012) and also Rubiera et al. (2017), the case of Madrid.

[4] As an example, see the case of Asturias studied in González et al. (2013).

the Household Budget Survey of the National Statistical Institute, in 2014, approximately 35% of the population lived in houses, with 11% living in detached houses and 24.2% in semi-detached houses (INE 2016). The remaining percentage of the population was distributed among other types of houses, such as flats. The strong changes in income per capita, social customs and land use have pressured for the increased presence of the urban sprawl phenomenon in Spain (Rubiera et al. 2016; Gómez-Antonio et al. 2016).

One of the most controversial issues is the relationship between urban sprawl and local fiscal stability (McGuire and Sjoquist 2002). The dispersion of a city increases the provisional costs of local public services, as it tends to undermine economies of scale and to increase costs inefficiently (Carruthers 2002; Carruthers and Ulfarsson 2003, 2008). Based on Carruthers (2002), low-density and spatially expansive development patterns are associated with a higher cost of public services, as considerable investments are required to extend basic infrastructure over greater distances to reach relatively fewer residents. Nevertheless, as Hortas-Rico (2014) explains, the dispersed cities could attract higher public resources or national funds associated with the construction activities: planning permits, construction taxes, and revenues from land value improvements through the sales of public land and assets. Additionally, if the public sector owns the land, it can internalise the benefit of public investments for development and capture the gains from the sales of land or increased property values (Peterson 2009). González et al. (2013) also find evidence that in Spain the municipalities located close to large metropolitan areas promote higher levels of sprawl through attracting population. Thus, this policy allows an inflow of higher fiscal resources for these municipalities, because the amount of transfers from the central government to the local councils is linked to the size of municipal population.

The existing empirical literature does not offer clear answers on the overall impact of sprawl on local revenues, fiscal sustainability and level of fiscal burden. Burchell and Listokin (1978) as well as Burchell et al. (2000) standardize a simulation method that evaluates the cost-revenue impact of a particular land-use development, named the Cost of Community Service (CCS). Since the seminal work of Burchell and Listokin (1978) many researchers have used this approach to evaluate the fiscal impact of alternative scenarios testing the effects of different urban densities and spatial patterns. A recent meta-analysis by Kotchen and Schutle (2009) summarizes the results in the compiled outcome of 125 CCS evaluations prepared for the US localities. The key finding of this literature suggests an increase in revenues along with the growing population and density, but the relevance of these variables clearly depends on the local factors, such as the structure of local economy and the scope of municipal services. For instance, the density loses its relevance in agricultural localities, and the population size appears less important for provision of school services. The conclusions may significantly vary by locations. Considering that this meta-analysis is conducted only for the US localities, the studies of other countries with different fiscal programs and local government responsibilities may not lead to the same results.

From the empirical perspective, the evidence of the impact of urban sprawl on fiscal sustainability is very limited. Heikkila and Craig (1991), Kelsey (1996),

Bunnell (1998), Carruthers (2002), and Carruthers and Ulfarsson (2003, 2008) study the impact of alternative residential developments on the fiscal position of local governments and find that, in general, local governments in more disperse areas present higher indebtedness. Through the contributions of Hortas-Rico and Solé-Ollé (2010) and Hortas-Rico (2014) Spain has been studied wider than other European countries. In Hortas-Rico and Solé-Ollé (2010), the impact of sprawl on local service costs is studied for a database of 2500 Spanish municipalities. In this study urban sprawl is measured by population density using the OLS methodology applied to the cross-sectional data from 2003. Meanwhile, Hortas-Rico (2014) study the relation between sprawl and local budgets using a panel vector autoregressive model with data from 4000 Spanish municipalities for the period from 1994 to 2005. Sprawl is mainly measured by means of density variables. Both studies conclude that sprawl increases local budget expenditures due to the higher cost of new infrastructure and greater provisional costs of local public services.

In contrast to the studies of the cost for providing public services focused on the revenues side of municipal budgets, we find little literature aimed at analysing the Spanish local tax burden (Martinez-Vazquez and Sans-Sanz 2007; Hortas-Rico and Solé-Ollé 2010). Most of them focus on specific geographic areas (Cárcaba García 2003; Lago Peñas 2004; Zafra and López 2006), and only a few studies include the entire national territory. In the latter case, we find the work of Carrasco et al. (2006), who carry out an exploratory analysis of the municipal tax burden depending on a series of socioeconomic and demographic control variables as well as the influence of political parties. The results show that economic development level, unemployment rate and immigration are significant variables in explaining the local fiscal burden. We also find works of Solé-Ollé (2006) and Bosch and Solé-Ollé (2007), who use a sample of more than 500 municipalities throughout the national territory in order to analyse the link between local budget outcomes and the intensity of party competition. In turn, Bosch et al. (2014) estimate an equation of the fiscal capacity for two main Spanish local taxes applied to 86 Spanish municipalities in 2008 and find that the central costs incurred by large municipalities are offset by their greater fiscal capacity, but that outcome is not true for the municipalities functioning as political/administrative capitals.

As Hortas-Rico and Solé-Ollé (2010) note the most fundamental point of empirical literature is the available capabilities for measuring the sprawl. Traditionally, the databases only permitted to approximate the measurements of sprawl defined by means of population density or density plus a combination of other demographic variables. However, the development of digital cartography with geo-referenced information allows for more precise and comparable measurements of sprawl. The use of this new approach for the quantification of sprawl allows for the ability to revise the empirical analysis, thus leading to new and interesting conclusions. This is an opportunity to obtain new evidence regarding the impact of sprawl on local fiscal programs by using sustainable geo-referenced information.

3 Studying the Spanish case: variables of local fiscal burden, urban sprawl index and other control variables

3.1 The spatial level of the analysis: Spanish urban municipalities

The first step for our analysis, especially relevant when we consider the complexity of local/regional institutional structures in Spain, is to properly delimit the level of spatial disaggregation and to define the spatial unit of analysis.

The highest level of spatial disaggregation of the public administration in Spain is the municipality. Spain is made up of 8114 municipalities.[5] Nevertheless, most of these municipalities are rural areas for which the studies of urban phenomena, such as urban sprawl, do not make sense. Interestingly, from the total number of municipalities about 84% have <5000 inhabitants and account for only about 13% of the total Spanish population (see Table 1). For comparison, the smallest municipalities with less than 5000 inhabitants combined have almost the same total population size as the two largest municipalities, with more than 1,000,000 inhabitants, Madrid and Barcelona municipal areas, which account for 10.38% of population. However, we cannot only follow a "population size" criterion in this study since most of the large urban areas or metropolises in Spain cover spaces far away from their municipal boundaries. For example, in Madrid or Barcelona the real city includes more than 50 municipalities; some of them are very small in terms of population but well-integrated into the dynamics of metropolitan area.

For the aforementioned reasons we select the municipalities that are clear urban areas based on one of the following factors: having a population of more than 50,000 inhabitants, being part of a metropolitan area or being located in its influence area. To determine the metropolitan areas and their areas of influence we use the official delimitation of the Spanish Government for the year 2011 (MFPA 2013).[6] This delimitation implies a total of 657 Spanish municipalities according to the official information. The main data is summarized in Table 1.

3.2 Local fiscal burden as a dependent variable: definition and measurement

Fiscal burden is defined as the total amount of taxes levied on the citizens of Spanish municipalities. An important aspect to emphasize is the lack of homogeneity in the calculation of fiscal burden. This is a complex task due to the great heterogeneity in both population density and socio-demographic characteristics (Benito Pérez et al. 2010). Several methods have been proposed to measure the potential revenues of a municipality: (i) tax collection; (ii) macroeconomic indicators, including municipal GDP or municipal income; and (iii) microeconomic indicators (Zafra and López 2006; Carrasco et al. 2006). In contrast, Cárcaba García (2003) defines fiscal burden as the volume of tax revenues relative to disposable household income, while

[5] Excluding the autonomous cities of Ceuta and Melilla that present a particular fiscal system.

[6] See Fig. 1 for the map of the Spanish municipal structure and the real urban extensions over the municipal borders.

Table 1 Municipalities and population in Spain, year 2011. *Source* Own elaboration derived from the MFPA database (2013)

Spain					
Number inhabitants (in thousands)	Number municipalities	% total in number of municipalities	Population (01/01/2011)	% in total population	Population/municipalities
> 1000	2	0.02	4,880,486	10.38	2,440,243
500–1000	4	0.05	2,743,809	5.83	685,952.25
100–500	57	0.70	11,186,947	23.79	196,262.23
50–100	80	0.99	5,696,848	12.11	71,210.60
20–50	253	3.12	7,499,173	15.95	29,641
5–20	922	11.36	9,034,186	19.21	9,798.47
< 5	6796	83.76	5,988,192	12.73	881.13
Total	8114	100	47,029,641	100	5796.11
Sample: extended urban zones (EUZ)					
Number inhabitants (in thousands)	Number municipalities	%	Population (01/01/2011)	%	Population/municipalities
> 1000	2	0.30	4,880,486	16.62	2,440,243
500–1000	4	0.61	2,743,809	9.34	685,952.25
100–500	52	7.91	9,921,453	33.78	190,797.17
50–100	74	11.26	5,327,459	18.14	71,992.69
20–50	111	17.05	3,404,624	11.59	30,672.29
5–20	240	36.53	2,619,183	8.92	10,913.26
< 5	174	26.33	472,581	1.61	2715.98
Total	657	100	29,369,595	100	44,702.58

This table shows the percentage of municipalities included in the sample, with the exception of Ceuta and Melilla. Nevertheless, the classifications for the Extended Areas related to USI are different, since they include the sprawled areas around the most populated municipalities. Thus, for instance, under these criteria Madrid or Barcelona include more than 50 municipalities

Delgado (2006) measures tax burden as the proportion of taxes (including Social Security contributions) in GDP.[7] Unlike these latter methods based on macroeconomic indicators, Bosch et al. (2014) use microeconomic ones through a Representative Tax System (RTS) by using the share of each type of tax in a representative budget, where the tax base is expressed in per capita terms.

According to macroeconomic indicators, neither the local GDP nor the disposable household income is available for municipalities in Spain, and both can only be assessed as proxy variables through indirect calculations, which would lead to rather inaccurate estimates of fiscal burden. Meanwhile, microeconomic indicators

[7] This author criticizes the mere use of "number of inhabitants" (population) in the definition of fiscal burden. She suggests the inclusion of socio-economic variables in order to be more accurate with the analysis of local fiscal burden.

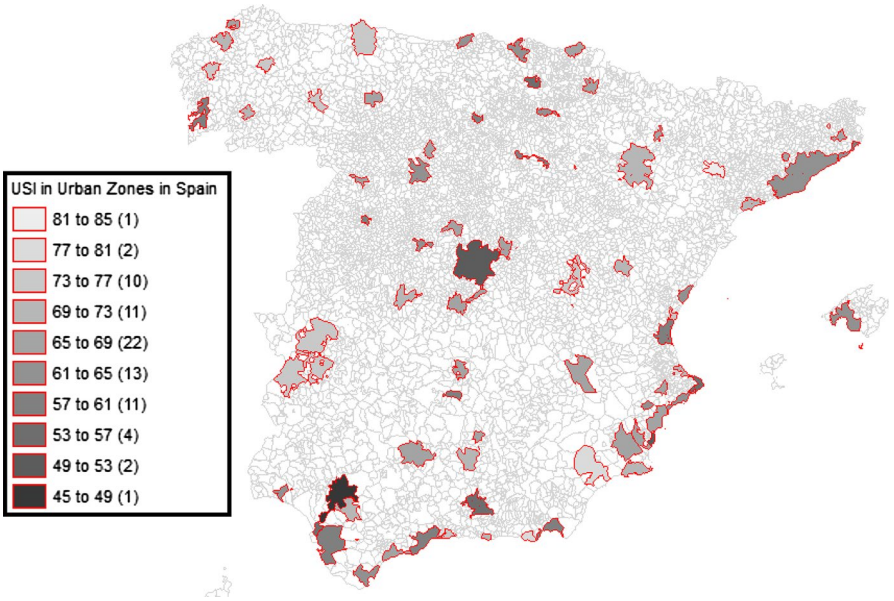

Fig. 1 Map of urban sprawl index for the major Spanish urban and metropolitan areas, 2001. For detailed information on the *USI* estimates for the major Spanish urban and metropolitan areas, please see Rubiera et al. (2016)

are only valid to measure the fiscal burden of individual households or citizens but not to determine the municipal tax burden from a macroeconomic perspective. For these reasons, in this study the tax burden is defined in the sense of tax collection, as the quotient between local tax revenues and the number of inhabitants, based on the first method mentioned above.

Some important aspects considered in the calculation of the fiscal burden are the following. The local financial system in Spain can obtain resources from their own assets, their taxes, current transfers and capital from other public entities, wealth income, sales of real investments and even resort to debt. The municipalities also obtain resources from the Autonomous Communities (the regional government in Spain); although, in the latter case this process varies across different regions leading to unequal and asymmetric developments (Fuster Asencio 2010). Additionally, municipalities receive grants drawn from central tax revenues without normative capacity or as a simple share of state revenues, according to various indicators of fiscal capacity and need (Delgado 2012).

In this study, we focus only on taxes, both-direct and indirect, corresponding to chapters I and II of the liquidated income budget, for two reasons. First, they are coercive and recurrent. Second, chapter III of the income budget (corresponding to fees and other revenues) has been heavily influenced throughout the period analysed by the urban activity and its inclusion would produce a bias in the estimates of local

fiscal burden.[8] In this sense, we use municipal liquidated taxes assuming that neither central government nor regional governments have influence over these revenues or, in other words, without including transfers (or other types of tax revenues) transferred from other layers of government.

The fiscal regime of the Spanish local taxes is dual and distinguishes between large municipalities (those with more than 75,000 inhabitants and capitals of provinces or regions) and the rest (with a special treatment for tourism jurisdictions). All Spanish municipalities impose three compulsory taxes: on property, economic activity, and motor vehicles. Besides, all municipalities above a certain population size tend to levy two non-compulsory taxes as well: tax on construction and building work and tax on the increase in the value of urban building land.

The local taxes can be divided into direct and indirect taxes. According to the *direct taxes* (in the chapter II of local revenues), along with the surcharges of state and regional direct taxes, four taxes stand out, where the municipalities have a greater autonomy when managing them:

- Tax on property: it is the main source of municipal revenues of real character and annual periodicity. It taxes the value of real estate, fundamentally the property rights. In particular, the measure for the tax base is the cadastral value of the properties located in the municipality.
- Tax on motor vehicles: it is periodic, levies annually, and has real and patrimonial nature. It registers the ownership of vehicles suitable for driving on public roads as consideration for local public services put to the service of traffic, such as differentiation by the use of equipment and engines of different power and the negative external effects caused by pollution. Its quotas are established by the central government, but municipalities can increase them by using a coefficient that ranges from 1 to 2.
- Tax on the increase in the value of urban building land: it taxes the increase in value experienced by urban land at the moment when the property or other rights are transferred. It lacks periodicity.
- Tax on economic activity: the municipal tax base (the so-called Cuotas mínimas) is the estimated content of each business, professional and artistic activity weighted by coefficients depending on the location and turnover of the activities present in the municipality. Therefore, it comprises the mere exercise of the economic activity but not the actual returns on the activity, which has caused to be a highly criticized tax. This has led to an increase in central government transfers to compensate for the loss of municipal revenues.

In relation to *indirect taxes*, only the tax on construction and building work applies. It accrues for the realization of any construction, installation or work which

[8] It would have been desirable to subtract, from chapter III, the share of revenues corresponding to the urban activity, but there is no available data, since we only have the information aggregated by chapters. Nonetheless, at the aggregate level, we have calculated that the revenues associated with urbanistic activities in chapter III for 2011 represented 2.19% from the total of non-financial revenues (MFPA 2013).

requires building (or urban) planning permit, so it is not periodic. It was created in 1988, and has no previous history (background) in Spain or in other countries.

3.3 Urban sprawl index as the main independent variable: definition and measurement

The phenomenon of urban sprawl has been studied within different disciplines (geography, town planning, territorial planning, environmental science, economics, sociology and even public health) from very different standpoints. See, for instance, Torrens (2008) for the reappraisal, and Salvati and Gargiulo-Morelli (2014) for studies of European cities. One of the main goals in the past decade in terms of the analysis of urban sprawl has hence been the creation of a precise definition of the concept that might also enable quantitative research.

Galster et al. (2001) make this effort and provide a definition that manages to encompass the complexity and multidimensionality of the phenomenon of urban sprawl. These authors define urban sprawl as "a pattern of land use in an urban area that exhibits some level of combination of eight dimensions: density, continuity, concentration, clustering, centrality, nuclearity, mixed use and proximity" (Galster et al. 2001). In a similar way Squires (2002) defines sprawl as "a pattern of urban and metropolitan growth that reflects low density, vehicle-dependency, and exclusion of new developments in the outskirts of settled areas often surrounding a deteriorating city".

Burchfield et al. (2005) go one step further in simplifying the concept and classify the phenomenon of urban sprawl as "whether the residential development is scattered or compact," such that "in the sprawling areas much of the land immediately surrounding the average house will not itself be developed". These authors therefore bring the definition of urban sprawl down to only one dimension, the degree to which building is dispersed. They propose an Urban Sprawl Index (USI) consistent with their definition, which can be obtained via the possibilities offered by Geographic Information Systems (henceforth, GIS). These authors specifically use TM Landsat imagery at a resolution of 30×30 m, providing photo interpretation in a raster GIS scenario. This scenario indicates the delimiting of the pixels of the image as urban or rural and for each pixel considered as urban counts the number of other urban pixels that fall within an area of 1 km^2 around it, and applies the following formula:

$$\mathrm{USI} = 100\left[1 - \frac{\text{Urban pixel}}{18^2\pi}\right] \tag{1}$$

Thus, high values of USI (up to 100) indicate high levels of dispersion or sprawl, while the low values indicate concentration (Burchfield et al. 2005). This paper similarly to Rubiera et al. (2016) applies estimates of USI to study the 657 municipal areas in Spain. The USI estimates are mapped in Fig. 1. The average USI for all Spanish urban areas is 68.81. There is a strong dispersion in this index within the territory: from the metropolitan area of Seville, with the lowest value of 48.13, to

Lleida, with the highest level of 81.12. Other important urban areas with a high level of sprawl include Madrid, Granada and Vitoria. At the other extreme are cities such as Caceres, Lugo and Santiago, with very low levels of sprawl. Barcelona, practically, presents the national average value.

3.4 Other control variables: definition and measurement

In addition to the *USI*, a total of eleven supplementary control variables are included in the analysis (Table 2). Except for two dummy variables, all other control variables are calculated using the databases from the Spanish National Institute of Statistics and the Spanish National Institute of Geography. These control variables, except for *USI*, are grouped into three main categories: demographic, socioeconomic, and geographic ones.

The changes in population size and cities' inability to expand their political boundaries to capture growing regions are correlated with increased numbers of abandoned structures and vacant land. For urban areas, congestion requires more services to be provided publicly. In rural areas, sparsity of population may reduce the needs for provision of services, but, the already provided public services may increase the "per unit" cost (Kim and Warner 2018). In this sense, for instance, Delgado (2012) includes the population or total assets, per capita income and per capita grants received as control variables to measure the local tax mix in Spain. Other studies also include the variables capturing the age structure and level of education of population; however, these variables do not have a significant effect on the local fiscal burden (Bosch et al. 2014). Besides, not only population size, but population structure, such as poverty, unemployment and racial characteristics, also matter. After the economic recession, austerity policies have exacerbated the already existing inequalities (Donald et al. 2014). We account the population structure with the percentage of foreign people (*FOREIN*), the employment ratio (*OCUP*) and the unemployment over population at the working age (*UNEM*).

Local fiscal burden was unequal across space even before the global economic recession (Lobao and Kraybill 2005) and we also expect higher costs of providing services for more urbanized areas and especially for core metropolitan municipalities with a highly concentrated population. For rural areas, the costs of public services are higher for nonadjacent places which cannot benefit from tax exporting or service spillovers from neighboring municipalities (Warner and Pratt 2005). For these reasons, we include the geographic variables that describe locations across Spain (e.g. *EASTING* and *COAST*) and adjacency to a metropolitan county (*DISTMA*). A few studies have tested whether geographic factors could also affect the fiscal capacity, e.g. Bosch and Solé-Ollé (2007) included a matrix of proximity to analyse tax mimicking, and, therefore, the analysis undertaken in this paper also represents a new contribution to the testing of this relationship.

In some ways, local public costs could also be seen as potential revenue raisers. Apart from the obvious cases of commuting (work, studies, shopping, administrative activities and leisure) and tourism, which are easily identified as potential sources of revenues for recipient municipalities through different channels, other

Table 2 Variables: description and descriptive statistics

Variable	Description	Source	Year	Median	Min	Max
Dependent variable: LFISBUR						
$LFISBUR_{11}$	Local fiscal burden	IEF (Spanish National Institute of Fiscal Studies)	2011	389.68	0	957.12
Main independent variable: USI01						
USI_{01}	Urban sprawl index calculated according with Eq. (1)	CNIG (Spanish National Institute of Geography)	2001	66.57	23.63	96.17
Control variables						
Socioeconomic variables (S)						
$SOCECI_{01}$	Socio-economic condition index	INE (Spanish National Institute of Statistics)	2001	1.03	0.67	1.36
$SPECI_{01}$	Specialization index of the local economy[a]	INE	2001	3.36	1.45	7.95
$LQPRIM_{01}$	Location quotient of primary sector in the local economy	INE	2001	89.34	2.94	631.27
$RATIOKIBS_{01}$	Percentage of employment in knowledge intensive business services	INE	2001	4.04	0.67	13.48
CAPITAL	Dummy variable that takes value 1 if the municipality is the capital of the autonomous community or province and 0 otherwise	–	–	–	0	1
Demographic variables (D)						
$OCUP_{01}$	Percentage of employed population over the sum of employed and unemployed population	INE	2001	0.62	0.40	0.80
$UNEM_{01}$	Percentage of unemployed population over population at the working age	INE	2001	11.48	1.43	33.11

Table 2 continued

Variable	Description	Source	Year	Median	Min	Max
$FOREIN_{01}$	Percentage of foreign population over total population	INE	2001	0.04	0.00	0.49
Geographical variables (G)						
EASTING	Location in terms of longitude	CNIG	–	−1.89	−8.85	3.13
COAST	Dummy variable that takes value 1 for the coastal municipalities and 0 otherwise	–	–	–	0	1
$DISTMA_{01}$	Distance (in Km) to a metropolitan area of more than 500,000 inhabitants	CNIG	2001	1.19	0	5.60

[a]The specialization index is calculated for each local area r applying this formula: $SPECI = Ln\left[\frac{1}{\sum_{i=1}^{n} Emp_i}\sqrt{\sum_{i=1}^{n}\left(Emp_i\left(LQ_i - 100\right)\right)^2}\right]$, where LQ_i is the location quotient of sector i for local area r; and E_i is the employment in sector i for area r. Accordingly, values tend to $-\infty$ when the degree of specialization in the local area is identical to that of the whole national economy; the value tends to $+\infty$ as the specialization profile of the local area diverges from the overall Spanish specialization (i.e., when the LLM is more specialized in one or more of the n sectors analyzed)

socioeconomic variables, including unit costs (wages) or activity substitution, could have a positive impact on a municipality's fiscal health. Indeed, all of them could attract more economic activity and, hence, increase directly and indirectly local tax revenues (Bosch et al. 2014). In this sense, the different levels of local fiscal burden across municipalities depend substantially on the housing boom-bust across those locations, which, in turn, have implications for both the economic and social outcomes. This situation influences the degree of investments (Dewar et al. 2015) and the quality of life in the cities (Lobao et al. 2014). Local governments, being aware of the mobility of higher income citizens and capital, increase the investments in the services which have developmental benefits (Peterson 1981). In this sense, the knowledge intensive services (also know as KIBS) represent a set of activities that are characterized by the high levels of innovations and contributions to the increased productivity; they involve intensive use of the highly skilled human capital and production of the information and knowledge products to serve their clients' needs (Camacho and Rodríguez 2005).[9] Therefore, the percentage of employment in these services (*RATIOKIBS*) is added to our model. Other socioeconomic indicators (e.g. *SOCECI*, *SPECI*, *LQPRIM* and *CAPITAL*) help to define the need for local public services in different municipalities and they are defined below.

The growth of a municipality and its potential tax revenues are markedly determined by different socioeconomic conditions. Thus, in the model we include a socioeconomic index (*SOCECI*), constructed by the Spanish National Institute of Statistics (INE). This index takes into consideration the variables of the assets of home, educational level and labour occupation of the main breadwinner of a household and assigns scores to their respective categories. In this way, each household receives scores respective to each category, which are further combined through an average calculation to arrive at the final single value. This combination implies the allocation of differentiated weights to each variable, depending on the relative importance that is granted to determine the socioeconomic level.

Another important issue related to the above is to determine the power and competitiveness of the municipality through its degree of specialization incorporating, for this reason, an index of specialization of the local economy (SPECI). We also control for the capital of the region (CAPITAL) that is a dummy variable that reflects whether or not the municipality is a capital of sub-central government. In addition, the activity and labor market of many former industrial cities have grown due to the development of the advanced tertiary sector (De Muero et al. 2011). Inversely, we include the variable *LQPRIM* which reflects the location quotient of primary sector in the local economy to measure the degree of presence of the primary sector in the municipality.

[9] We include the branches of service activities such as accounting and legal services, architecture, audiovisual, engineering, software, advertising, research and development (R&D), or health and education services.

3.5 Time period of the analysis

Regarding the time period used in the paper, we assume that a phenomenon, such as urban sprawl, does not produce an immediate impact on fiscal burden. Consequently, it is necessary to have a significant time lag to be able to observe an impact that urban sprawl may have on fiscal burden. However, we are limited by the data availability of the calculated sprawl index. All considered variables, original sources of data and descriptive information are summarized in Table 2.

4 Empirical model and econometric strategy

Based on the above information, the basic empirical model proposed can be written as

$$LFISBUR_{11} = \beta_0 + \beta_1 USI_{01} + \left[\beta_S S_{01} + \beta_D D_{01} + \beta_G G_{01}\right] + u \tag{2}$$

where

$LFISBUR_{11}$ local fiscal burdens for 2011 (Sect. 3.1)
USI_{01} urban sprawl index in 2001, main independent variable (Sect. 3.2)
S_{01}, D_{01}, G_{01} vectors with socioeconomic, demographic and geographical control variables (Sect. 3.3 and Table 2)
u random error term of the estimation

Equation (2) could be estimated by ordinary least squares (OLS) regression, but we are interested to observe the effects that control variables may have along the entire distribution of fiscal burden. This is possible using the quantile regressions (QR) approach (Koenker and Basset 1978).

The following expression presents the adaptation of Eq. (2) in terms of QR:

$$LFISBUR^{\tau}_{11} = \beta^{\tau}_0 + \beta^{\tau}_1 USI_{01} + \left[\beta^{\tau}_s S_{01} + \beta^{\tau}_D D_{01} + \beta^{\tau}_G G_{01}\right] + u \tag{3}$$

where coefficients β^{τ}_i represent the returns to covariates at the τth quantile of the local fiscal burden. The model is estimated by using the least-absolute value minimization technique, and the bootstrap estimates of the asymptotic variances of the quantile coefficients are calculated with 20 repetitions.

We compare the estimates from the OLS regression with those of QR model in different quantiles, with a focus at $\tau = 0.25; 0.5$ and 0.75, and use three regression models to evaluate the impact of the explanatory variables on the fiscal burden with consideration of the type of taxation: direct, indirect and aggregate of both. Thus, the OLS regression models the relation between the independent variables (USI, and combination of socioeconomic, demographic and geographic variables) and the conditional mean of the dependent variable (local fiscal burden). In addition, the QRs model the relationship of the same explanatory variables and the conditional quantiles of the response variable and more comprehensively illustrate the effects of independent variables on the studied variable.

Table 3 OLS and QR estimates of the local fiscal burden with all taxes

	OLS	QR		
		0.25	0.50	0.75
Constant	− 200.70 (− 1.57)	− 80.84 (− 0.60)	− 166.94 (− 1.10)	− 414.18 (− 2.71)***
USI_{01}	1.72 (3.40)***	1.06 (1.99)**	2.01 (3.32)***	2.87 (4.72)***
$SOCECI_{01}$	612.85 (5.01)***	379.74 (2.94)***	577.48 (3.95)***	730.02 (4.98)***
$SPECI_{01}$	18.56 (2.82)***	− 0.43 (− 0.06)	15.41 (1.96)**	27.57 (3.50)***
$LQPRIM_{01}$	− 0.15 (− 2.24)**	− 0.09 (− 1.25)	− 0.09 (− 1.13)	− 0.20 (− 2.59)***
$RATIOKIBS_{01}$	13.91 (3.02)***	11.51 (2.37)**	14.54 (2.65)***	15.85 (2.88)***
CAPITAL	49.19 (2.49)**	64.59 (3.10)***	71.51 (3.03)***	49.14 (2.08)**
$OCUP_{01}$	− 475.56 (− 2.26)**	− 245.03 (− 1.10)	− 507.85 (− 2.02)***	− 448.21 (− 1.78)*
$UNEM_{01}$	4.26 (2.04)**	4.63 (2.10)**	3.08 (1.23)	6.18 (2.47)**
$FOREIN_{01}$	422.85 (3.78)***	270.95 (2.30)**	598.71 (4.48)***	765.77 (5.71)***
$DISTMA_{01}$	− 23.84 (− 3.95)***	− 17.28 (− 2.72)***	− 27.37 (− 3.80)***	− 21.74 (− 3.01)***
EASTING	10.38 (3.82)***	9.57 (3.34)***	6.91 (2.13)**	12.02 (3.70)***
COAST	65.34 (4.86)***	53.34 (3.77)***	56.17 (3.50)***	68.24 (4.24)***
R^2	0.40			
Pseudo R^2		0.24	0.25	0.28
F-Change	34.36			
Number of observations (municipalities)	657			

To overcome any possible autocorrelation and heteroskedasticity in the error terms of the models, a heteroskedasticity and autocorrelation consistent estimator is used to provide a robust estimation of the covariance matrix of the parameters of a regression-type model

*, ** and *** represent estimates significantly different from zero at 10, 5 and 1%, respectively

5 Main results

Table 3 presents the results obtained for OLS and QR estimates using all local taxes in the calculation of the fiscal burden as a dependent variable. A heteroscedasticity and autocorrelation consistent estimator is used to provide a robust estimation of the covariance matrix of the parameters of a regression-type model. The first column of the table presents the estimated coefficient of the OLS regression. The following three columns report the coefficients and t-statistics for the QR quantiles (τth): 0.25, 0.50 and 0.75. Basic tests, including the R^2, F-Change and Pseudo R^2 for the QR, are presented in the end of the table. In order to investigate which type of taxes could be more affected by urban sprawl and to observe the robustness of the results under different conditions. Table 4 provides information on the same model but uses only direct taxes as a measure of the fiscal burden while Table 5 reports the same results for indirect taxes.

Table 4 OLS and QR estimates of the local fiscal burden with direct taxes

	OLS	QR		
		0.25	0.50	0.75
Constant	− 162.31 (− 1.31)	− 101.84 (− 0.72)	− 163.15 (− 1.19)	− 278.66 (− 1.79)*
USI_{01}	1.40 (2.85)***	0.97 (1.74)*	1.53 (2.81)***	1.59 (2.57)***
$SOCECI_{01}$	618.77 (5.21)***	378.87 (2.81)***	569.35 (4.32)***	782.62 (5.24)***
$SPECI_{01}$	19.66 (3.08)***	4.36 (0.60)	14.25 (2.01)**	24.82 (3.09)***
$LQPRIM_{01}$	− 0.12 (− 1.86)*	− 0.07 (− 0.97)	− 0.07 (− 1.01)	− 0.13 (− 1.68)*
$RATIOKIBS_{01}$	11.75 (2.63)***	10.45 (2.06)**	12.42 (2.51)**	11.56 (2.06)**
CAPITAL	33.80 (1.76)*	54.79 (2.52)**	51.45 (2.42)**	20.34 (0.84)
$OCUP_{01}$	− 523.67 (− 2.56)**	− 230.10 (− 0.99)	− 473.63 (− 2.09)**	− 581.04 (− 2.26)**
$UNEM_{01}$	3.54 (1.74)*	4.24 (1.84)*	3.64 (1.62)	3.72 (1.46)
$FOREIN_{01}$	415.61 (3.82)***	267.53 (2.17)**	588.47 (4.88)***	773.07 (5.66)***
$DISTMA_{01}$	− 25.82 (− 4.41)***	− 23.28 (− 3.50)***	− 26.35 (− 4.06)***	− 24.60 (− 3.34)***
EASTING	10.24 (3.63)***	9.34 (3.12)***	8.05 (2.75)***	8.85 (2.67)***
COAST	66.72 (5.11)***	51.87 (3.50)***	60.68 (4.19)***	74.21 (4.52)
R^2	0.40			
Pseudo R^2		0.26	0.25	0.28
F-Change	35.42			
Number of observations (municipalities)	657			

To overcome any possible autocorrelation and heteroskedasticity in the error terms of the models, a Heteroskedasticity and Autocorrelation Consistent estimator is used to provide a robust estimation of the covariance matrix of the parameters of a regression-type model

*, ** and *** represent estimates significantly different from zero at 10, 5 and 1%, respectively

5.1 Results addressing *USI*

After controlling for other variables mentioned in Sect. 3.4, the OLS regression detects a clear effect of urban sprawl index on local fiscal burden (at 1 percent significance). This indicates that local fiscal burden is significantly higher in the municipalities that have sprawled areas.

The next set of quantile estimates (QR methodology) looks at the impact of urban sprawl index along the distribution of local fiscal burden, including all local taxes. As shown in Fig. 2a and Table 3, the *USI* coefficient is estimated to be significant and positive throughout the distribution of local fiscal burden. The level of significance as well as the size of the effect is however lower in the 0.25 quantile (at the limit of 5%) than in the upper quantiles (0.5 and 0.75) (at 1%). Therefore, the *USI* is a more important determinant of the fiscal burden in municipalities that already have a high fiscal burden.

Table 5 OLS and QR estimates of the local fiscal burden with indirect taxes

	OLS	QR		
		0.25	0.50	0.75
Constant	−38.39 (−1.91)*	5.75 (0.49)	−12.34 (−0.75)	−37.00 (−1.49)
USI_{01}	0.32 (4.01)***	0.03 (0.67)	0.21 (3.25)***	0.34 (3.43)***
$SOCECI_{01}$	−5.91 (−0.31)	4.73 (0.42)	−12.42 (−0.79)	−13.80 (−0.58)
$SPECI_{01}$	−1.10 (−1.07)	−0.08 (−0.14)	−0.33 (−0.39)	0.12 (0.09)
$LQPRIM_{01}$	−0.03 (−2.72)***	0.00 (0.28)	−0.01 (−1.84)*	−0.03 (−2.56)**
$RATIOKIBS_{01}$	2.16 (2.99)***	1.43 (3.41)***	2.54 (4.28)***	4.21 (4.72)***
CAPITAL	15.39 (4.96)***	21.95 (12.19)***	18.52 (7.26)***	12.45 (3.25)***
$OCUP_{01}$	48.11 (1.45)	−18.06 (−0.94)	21.60 (0.79)	46.76 (1.14)
$UNEM_{01}$	0.72 (2.20)**	−0.01 (−0.05)	0.26 (0.96)	0.65 (1.60)
$FOREIN_{01}$	7.24 (0.41)	2.78 (0.27)	3.82 (0.26)	23.15 (1.07)
$DISTMA_{01}$	1.99 (2.10)**	0.71 (1.28)	0.53 (0.68)	2.24 (1.92)*
EASTING	0.14 (0.33)	0.14 (0.57)	−0.24 (−0.67)	−0.34 (−0.65)
COAST	−1.38 (−0.66)	−0.96 (−0.78)	1.68 (0.97)	−0.29 (−0.11)
R^2	0.13			
Pseudo R^2		0.11	0.13	0.13
F-Change	35.42			
Number of observations (municipalities)	657			

To overcome any possible autocorrelation and heteroskedasticity in the error terms of the models, a Heteroskedasticity and Autocorrelation Consistent estimator is used to provide a robust estimation of the covariance matrix of the parameters of a regression-type model

*, ** and *** represent estimates significantly different from zero at 10, 5 and 1%, respectively

The OLS results for the effect of the *USI* on the local fiscal burden for both direct taxation (Table 4) and indirect taxation (Table 5) are statistically significant at 1%. According to the QR methodology, the test again detects significance in the relation between the USI and the local fiscal burden in direct taxes (Fig. 2b). However, the impact of *USI* is less clear in the case of indirect taxation (Fig. 2c). Thus, *USI* has a significant effect on the higher levels of conditional distribution (0.5th and 0.75th quantiles) of the local fiscal burden in indirect taxes, but the effect is not statistically significant in the lowest one (0.25th quantile). This is related to the characteristics of local indirect taxation in Spain, which is mainly focused on the taxation of construction activities. Urban sprawl has a direct impact only on the municipalities with a strong presence of these activities and, therefore, the higher fiscal revenues from indirect taxes. Moreover, this situation is not so different in the case of direct taxation (notice that the lowest quantile, 0.25th, is significant at 10%). Local direct taxation depends substantially on housing prices across locations (affecting mainly tax on property as well as tax on the increase in the value of urban building) and its derivatives (affecting tax on motor vehicles necessary for commuting, and so on) which influences the degree of investments in the city (and its tax on

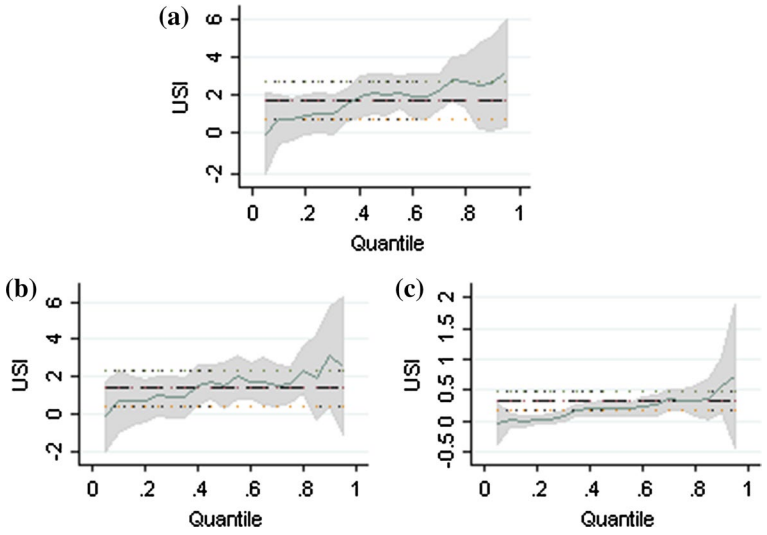

Fig. 2 Effect of urban sprawl index along the conditional distribution of local fiscal burden. **a** Effect using total local fiscal burden, **b** effect using local direct taxes, **c** effect using local indirect taxes

economic activities). Then, it is straightforward to see that the municipalities with more sprawled areas are the ones with higher fiscal burden, considering both direct and indirect taxes.

From the technical standpoint, the discrepancy in outcomes of the OLS and QR methodologies justify the use of QR as a more accurate econometric instrument for defining the effects of urban sprawl on the distribution of local fiscal burden in Spain. Additionally, the discussed outcomes confirm the usefulness of the strategy for analysing the tax burden through different types of taxation. OLS detects a strong statistical significance between the USI and all taxes; this result also holds when the direct and indirect taxes are studied separately. The QR methodology adds to this insight by indicating that USI is less significant in the lowest quantile of direct taxes (10%) and not significant in the case of indirect taxes, while also confirming a significant contribution to the higher levels of conditional distribution of fiscal burden (0.5 and 0.75th quantiles) in all taxes, direct and indirect ones (Fig. 2a, b, c).

5.2 Results addressing other control variables

All considered control variables are significant and have the expected signs in the OLS estimation (column 2 in Table 3). In general, these outcomes are in line with the previous empirical literature on the causes of local fiscal burden [Sect. 3.3 and the recent studies on Spain by Bosch and Solé-Ollé, (2007) and Bosch et al. (2014)]. Thus, all variables increase the local fiscal burden in Spain, except for the cases of *LQPRIM, DISTMA* and *OCUP*, which have coefficients with negative signs throughout the distribution of local fiscal burden. This means that a higher location quotient

of primary sector in the economy (*LQPRIM*), distance to a metropolitan area of more than 500,000 inhabitants (*DISTMA*) or a higher occupancy rate of a municipality (*OCUP*) reduces the local fiscal burden. Besides, all variables are equally significant (at 1% significance) with the exception of those related to the labor market conditions (*OCUP* and *UNEM*) and *LQPRIM* which are significant at 5%.[10]

Regarding the discussion of the control variables and their impact across the different quantiles, it is important to note that the model is consistent with the theoretical approach and the signs of coefficients remain as expected. Nevertheless, the QR results reveal interesting additional information about these variables. Thus, we found that overall the local fiscal system in Spain is progressive, where the taxpayers in the higher conditional distribution of fiscal burden contribute more significantly in supporting the fiscal sustainability of municipalities and the main fiscal sources are drawn from the direct taxation. As a consequence, a similar pattern is observed for the whole sample (including all taxes) and for the case of direct taxation. However, when the estimations are focused on indirect taxes, most of the variables lose their significance.

From the QR estimations for all taxes, we observe that *geographic variables* (*DISTMA*, *EASTING* and *COAST*) have a strong relationship with the local fiscal burden at each quantile, mostly at 1% significance. The same results have been found for these variables throughout the conditional distribution of direct tax burden (equally at 1% in all cases). Therefore, geography matters in the process of municipal development and, therefore, in its tax burden. The results for *EASTING* and *COAST* reflect the higher urban sprawl process in the Spanish Mediterranean coast (Catalan et al. (2008); Muñoz (2003)). Notice that in the case of the distance to a metropolitan area of more than 500,000 inhabitants (*DISTMA*), the tests assess a very significant negative relationship, suggesting a lower fiscal burden outside the large metropolitan areas.

Regarding the *demographic variables*, the results are not so homogeneous. The percentage of foreign population over total population (*FOREIN*) is clearly significant across the entire distribution of the local fiscal burden, for both all taxes and direct taxes. However, the variables related to the labor market, *OCUP* and *UNEM*, present multiple responses to the local fiscal burden. As a result, these variables are not significant throughout the distribution of the local tax burden for all taxes. For the case of direct taxes, the occupation rate is not significant at the 0.25th quantile and is becoming significant at the higher quantiles (0.5th and 0.75th). Conversely, the unemployment rate only affects the municipalities with the lowest fiscal burden. This means that whilst the unemployment rate only corresponds to the fiscal burden of municipalities with relatively lower tax resources, the increase in occupation rate only diminishes the resources (negative sign) of municipalities with the highest tax burden. The municipalities with the lowest tax burden are more sensitive to the unemployment rate but, logically, not the municipalities with higher tax burden, which benefit from the tax collection from their employed population. Economically,

[10] The variable CAPITAL is significant at 1.3% level. Despite it must be considered significant at the level of 5% (**), according to the branches established, it is closer to the significance at 1% level (***).

these results indirectly suggest a consistency of the local fiscal system since the local direct taxes on property, land and number of motor vehicles may be relatively lower in the areas with a higher occupation rate due to the increased influx of businesses and population, leading to the reduction in the local fiscal burden per inhabitant.

Similarly, according to the *socioeconomic indicators,* overall the fiscal pressure has a progressive nature particularly in direct taxation. However, our analysis suggests some inconsistecies across the conditional distribution of the fiscal burden. Thus, while some variables such as *SOCECI*, *RATIOKIBS* and *CAPITAL* are highly significant in explaining the local fiscal burden across all quantiles, others like *SPECI* and especially *LQPRIM* are not always significant, depending on the case considered. Particularly, a greater degree of specialization in the primary sector (*LQPRIM*) is significant (coefficient with negative sign) in relation to the municipalities with the highest level of tax burden (in the 0.75th quantile) and it is not relevant in the rest of the cases. Similarly, the divergence of the specialization index of the local economy from the overall Spanish specialization (SPECI) is not significant among the municipalities with the lowest tax burden, while its significance increases as the fiscal burden of municipalities rises (significant at 5% in the 0.5th quantile and at 1% in the 0.75th quantile). These results are coherent across all taxes and direct taxes. However, there are a few considerations to bear in mind from the QR estimations. First, the pattern of SPECI coincides in both all taxes and direct taxes across the distribution of local tax burden, but the LQPRIM is mostly irrelevant. Second, despite *SOCECI, RATIOKIBS* and *CAPITAL* being significant across the quantiles, in the case of direct taxes the significance of the latter two variables is lower, and *CAPITAL* is not relevant in the highest quantile. Particularly, the cities that are capitals of the Spanish Autonomous Communities or Provinces (*CAPITAL*), which have to provide a larger range of public services, also contribute in higher tax burden. Here, we observe that the fiscal programs are supported by both direct and indirect taxation. The analysis suggests that the tax burden with respect to direct taxes, is comparatively evenly distributed, with the only exception for the highest quantile.

Finally, in the case of *indirect taxes*, only a few variables from the original model maintain their significance observed in the OLS regression. In particular, this applies to some socioeconomic variables; in particular, the ones closely related to the specialization of the economic activity (*LQPRIM, RATIOKIBS* and *CAPITAL*), the unemployment ratio (*UNEM*) and the distance to a metropolitan area of more than 500,000 inhabitants (*DISTMA*). However, the results under the QR estimation for the same variables show that, while both *RATIOKIBS* and *CAPITAL* remain strongly significant throughout the distribution of fiscal burden (at 1%), *LQPRIM* only shows a significant (and negative) impact for the median (10% significance) and the highest (0.75th) quantiles. In the case of UNEM, only the OLS estimation detects significant effects on fiscal burden (at 5%) while *the* QR method does not show any significance throughout the conditional distribution whatsoever. Similarly, in the case of *DISTMA*, the OLS estimation suggests the significance of a change in the distance to a metropolitan area on fiscal burden; however, the QR does not find evidence of strong causality (only in the highest quantile at 10% significance level).

In the context of the effects of these explanatory variables on the fiscal burden related to indirect taxation, it can be assumed that the fact of being a capital (*CAPITAL*) and, to a lesser extent, the further distance from a metropolitan area (*DISTMA*); the specialization in the knowledge intensive business services (*RATIOKIBS*); and the further distance from the primary sector of local economy (*LQPRIM*) may promote construction activities which, in turn, can increase the local revenues related to indirect taxation (notice tax on construction and building work is the main indirect local tax in Spain). On the other hand, Spanish municipalities not only collect local taxes but they receive intergovernmental transfers covering the expenditures associated with the size of municipal population. Although these transfers have not been taken into account in this analysis, the results of this study may suggest the inclusion of other alternative criteria (apart from size population), such as geographic and socioeconomic variables, in order to determine the amount of transfers from the central government to the local councils to eventually determine the fiscal burden of the different municipalities.

6 Conclusions and policy implications

The primary objective of this paper was a thorough study of the effects of urban sprawl on local fiscal burden, while also considering a number of socio-economic, demographic and geographic control variables, applied to the case of Spain. The evidence accumulated by the existing literature indicates that higher levels of sprawl undermine the economies of scale in the provision of public services and increase the needs for investments in the infrastructure of larger areas with lower density. But, at the same time, the sprawled areas are more attractive to construction development companies and for influx of population and, according to the Spanish fiscal system, both are relevant factors to increase the fiscal revenues of these municipalities.

We find that in general sprawled cities have a higher fiscal burden. This result is coherent with the previous studies by Hortas-Rico and Solé-Ollé (2010) and Hortas-Rico (2014). Therefore, our results about the effects of urban sprawl on the fiscal burden can be considered consistent with the existing literature.

Overall, this positive relationship remains across all types of taxation and throughout the entire conditional distribution of local fiscal burden, with the only exception of the lowest quantile (0.25th) in the case of indirect taxes. Nonetheless, urban sprawl is more relevant for the municipalities at the upper end of the conditional distribution of the fiscal burden. This is mainly associated with an influx of local revenues derived from the real estate boom, especially in the Spanish Mediterranean coast (direct taxation) and also from the construction and development activities linked to the growth of knowledge intensive business sectors. Meantime, the most traditional primary sector of proximity to a metropolitan area is characterized by the negative relation along the entire distribution of fiscal burden (direct taxation), while the fact of being a capital is more relevant to indirect taxation. Besides, the findings reveal that, apart from urban sprawl, geographic variables are important in explaining the Spanish local fiscal burden, especially for the fiscal burden of

direct taxation. The socioeconomic indicators by contrast are more closely related to the fiscal burden of indirect taxation.

Despite some data limitations, this current study suggests a number of relevant policy implications. First, according to our results, relaxing the urban planning or the land policies in order to increase local fiscal revenues could destabilize the fiscal sustainability in the long-run. Second, we find that compact cities are not only more sustainable in terms of energy consumption or social stability, as several research studies have highlighted, but also seem to be more sustainable in terms of fiscal burden. Finally, urban planning, in addition to being a land use and environmental tool, should also be considered relevant from a fiscal perspective.

Acknowledgements We would like to thank the editor Peter Huber, and two anonymous referees for their helpful comments and suggestions. The first author, as a visiting scholar in the IRPET, would like to express her very great appreciation to Patrizia Lattarulo and also Claudia Ferretti for their valuable and constructive suggestions during the second review of this research work.

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